SURVEY OF APPLE JUICE PACKED IN 1946

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Five years have passed since we conducted the last survey of commercial apple juice.[3/] [4/] It was therefore decided to repeat it on the 1946 pack, in order to learn what changes had taken place and what trends are apparent. This survey did not include the pulpy type of apple juice, nor that sold without processing.

The main objectives of this survey were: (1) To determine the effects of composition, appearance, processing methods, varieties, region, and container on typical apple flavor; (2) to determine the chief characteristics of the typical apple juice packed in 1946; (3) to determine any trend in flavor since 1940 and 1941; (4) to collect production data.

Procedure

With the help of R. E. Marshall of Michigan State College, the container companies, and the Canners Directory, we compiled a list of 180 possible juice processors. Each packer was invited to submit his product under a confidential code number, which was used during all scoring and analyses. A questionnaire also was included requesting information on: (a) varieties of apples used, (b) storage of apples, (c) methods of processing, (d) whether deaeration was employed, (e) whether ascorbic acid was added, (f) whether apple essence was added, (g) whether carbonation was applied, (h) cooling time after pasteurization, (i) type of container, and (j) total pack from 1946 crop.

The samples were solicited in May and analyzed and tasted in June, 1947. We purposely waited until this period of the year, first, because it would represent the average shelf life of the pack and, second, because we feel that there can be a big market for apple juice during the "thirsty" summer season, and we wanted to see what quality of juice is available then.

Of 90 companies replying, 29 submitted 36 samples, 6 had none available, 1 did not care to participate, 33 gave their production figures, 16 did not pack in 1946, and others were not packers or had discontinued. The 90 who did not reply probably are mostly producers of fresh juice or were on the various lists by mistake.

1/ Eastern Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

2/ National Apple Institute, 726 Jackson Place, Washington 6, D. C.

3/ "Survey of Apple Juice Packed in 1940," H. H. Mottern, Truman Nold, and J. J. Willaman. Fruit Prod. J. 21, No. 3, 68-71 (1941).

4/ "Survey of Apple Juice Packed in 1941," H. H. Mottern, Truman Nold, and J. S. Hudnut. United States Department of Agriculture, Bureau of Agricultural and Industrial Chemistry ACE-186. 1942 (Processed.)

The 36 samples were received from 9 packers in New England and New York, 5 in the Appalachian area, 13 in the North Central region, and 3 on the Pacific coast. Table 1 shows the total production in these areas, including companies who did not submit samples.

TABLE 1

GEOGRAPHICAL DISTRIBUTION OF PROCESSORS AND THEIR PRODUCTION IN GALLONS

	Number of Companies[1/]	Reported Production, gallons
New England and New York	9	3,793,734
Appalachian area	5	2,955,353
North Central region	14	2,324,839
Pacific coast	5	1,702,454
Total	33	10,776,380

1/ Includes those which did not submit samples

The 29 judges, all experienced in judging apple juice, were: R. E. Marshall, Michigan State College; Z. I. Kertesz, Cornell University; J. W. Beidler, H. C. Musselman Company; Lionel Newcomer, Berks-Lehigh Cooperative Fruit Growers, Inc.; J. R. Oyler, Knouse Corporation; H. H. Mottern, H. J. Heinz Company; H. Lineweaver and J. Matchett of the Western Regional Research Laboratory; and our laboratory taste panel of 21 persons.

On the premise that typical apple flavor is the most important characteristic of apple juice, scoring was based on this factor alone. Specific gravity (^{o}Brix), percent malic acid, pH, and ascorbic acid content, shown in Table 2, were not considered. No attempt was made to determine the taster's explanation for off-flavor because of varied opinions in past surveys.

TABLE 2. DATA ON APPLE JUICE SAMPLES SUBMITTED IN 1946 SURVEY

Packer's Code No.	Container 1/	Varieties used 2/	Storage of Apples	Treatment Before Pasteurization 3/	Deaerate	Ascorbic Acid Added	Ascorbic Acid Found mg/100 cc	Clarity	Sediment	Degrees Brix	pH	Acidity as Malic Acid %	Typical Apple Flavor 1940	Typical Apple Flavor 1941	Typical Apple Flavor 1946
3	G	8,17,18	cold	P	-	-		clear	0	11.7	3.8	0.37	8	6	4
8	G	12,13,19,22	cold, common	C	-	+	15	cloudy	++	12.6	3.4	0.40	10	8	6
18	G	1,15,16	fresh	C	-	+	44	clear	0	13.0	3.4	0.49	4	4	4
22	G	1,11,13,15,16,25	common	DF	-	-		clear	0	12.3	3.4	0.41	-	6	5
24	G	2,15,20	common	P	-	-		clear	0	14.2	3.5	0.48	-	-	3
24a	G	2,15,20	common	P	-	+	57	clear	0	12.0	3.5	0.42	-	-	2
27	G		fresh	DF	-	-		cloudy	0	13.3	3.7	0.41	-	4	6
27a	G	15	fresh	DF	-	-		clear	0	12.4	3.8	0.36	-	-	6
30	G	7,13,15,16,23,27	cold	P	-	-		clear	0	14.5	3.5	0.57	-	4	7
36	G	13,15,22,25	....	C	-	-		cloudy	0	12.3	4.0	0.22	-	6	3
38	G	19,26,28	fresh	H	-	-		hazy	0	12.6	3.3	0.50	8	8	4
44	G	8,18	cold	P	-	-		clear	0	14.4	3.7	0.34	-	-	7
44a	G	18,26	common	P	-	+	48	clear	0	14.2	3.6	0.37	-	-	7
46	G	6,8,18	common	DF	-	-		clear	0	14.0	3.7	0.40	6	6	8
46a	G	6,8,18	cold	DF	-	+	39	clear	0	13.6	3.8	0.37	6	6	6
51	M	1,11,16,27	common	DF	-	-		cloudy	0	12.7	3.6	0.42	6	4	5
51a	G	1,11,16,27	common	DF	-	-		cloudy	0	13.0	3.5	0.46	-	-	3
52	M	13,22,26	fresh	H	+	-		cloudy	0	12.3	3.7	0.36	8	4	2
53	G	8,11,22,26,28	common	C	+	-		cloudy	++	12.5	3.6	0.38	4	4	2
55	M	1.13.26	fresh	H	-	-		clear	0	12.4	3.4	0.51	8	6	3

62	M	1, 11, 15, 16	common, fresh	DF	-	-		cloudy	0	12.7	3.6	0.44	-	-	6
63	M	7, 10, 15, 21	fresh	HB	-	-		cloudy	+	12.5	3.4	0.54	6	8	5
63a	G	7, 10, 15, 21	fresh	HB	-	-		clear	0	12.2	3.2	0.61	-	-	5
71	M	8, 11, 13, 22	fresh	P	-	-		clear	0	13.8	3.7	0.43	6	6	4
73	G	1, 8, 10, 16	fresh	GT	-	-		clear	0	15.2	3.2	0.55	6	6	6
77	G	1, 8, 10, 12, 22	cold	P	-	-		clear	0	12.0	3.9	0.24	6	4	3
79	M	1, 8, 10, 15 16, 21, 23	fresh	P	-	-		clear	0	13.7	3.7	0.50	-	-	7
82	M	8, 13, 16, 23	fresh	-	-	-		cloudy	++	12.9	3.7	0.39	8	6	3
84	G	1, 10	fresh	GT	-	-		clear	0	12.0	3.5	0.32	8	6	6
94	G	4, 18, 26, 28	common	C	-	+	13	cloudy	+	12.4	3.4	0.40	-	8	5
109	M	1, 12, 15, 16	cold, common	DF	-	-		hazy	0	11.7	3.4	0.55	-	-	2
117	M	1, 10, 14, 25	common	H	-	-		hazy	0	12.5	3.5	0.53	-	-	3
142	M	1, 8, 16, 23	common	HB	-	-		cloudy	0	13.3	3.5	0.51	-	-	3
146	G	11, 13, 15, 25	cold	P	-	-		clear	0	14.1	3.3	0.52	-	-	4
146a	G	11, 13, 15, 25	cold	B	-	-		clear	0	13.0	3.4	0.47	-	-	6
183	M	1, 15	fresh	DF	-	-		cloudy	0	11.5	3.5	0.35	-	-	2
		Average								12.9	3.6	0.43	6[4]	6[4]	5
													7[5]	6[5]	

1/ G = Glass
M = Metal

2/ See Table 3

3/ P = Pectinol clarified
C = Centrifuged
DF = Direct filtration
H = Heat coagulation
HB = Heat coagulation and bentonite
B = Bentonite
GT = Gelatin-tannin

4/ Includes only samples duplicated in 1946

5/ Includes all samples

The scale of 10 to 1 was defined as: 10-9, excellent, 8-7, good, 6-5, fair, 4-3, poor, and 2-1, objectionable.

Results and Conclusions

Table 2 gives the analytical data and the flavor scores. Table 3 is a list of the variety code numbers. Table 4 shows the relation between various factors and flavor score.

TABLE 3

CODE TO VARIETIES

Code No.	Variety	Frequency of Use
1	Baldwin	14
2	Ben Davis	2
3	Black Twig	1
4	Bonum	1
5	Winter Banana	1
6	Bellflower	1
7	Cortland	2
8	Delicious	12
9	Gravenstein	1
10	R. I. Greening	7
11	Grimes Golden	6
12	Golden Delicious	5
13	Jonathan	12
14	King	1
15	McIntosh	14
16	Northern Spy	10
17	Ortley	1
18	Newton-Pippin	6
19	Rome Beauty	2
20	Stark	1
21	Snow	1
22	Stayman	9
23	Steele's Red	4
24	White Pearmain	1
25	Wealthy	4
26	Winesap	7
27	Wagener	3
28	York Imperial	4

TABLE 4

RELATION OF VARIOUS FACTORS TO FLAVOR SCORE

	Number of samples having score of							TOTAL
	8	7	6	5	4	3	2	
Container								
Glass	1	3	7	3	3	5	2	24
Metal		1	1	2	1	4	3	12
Storage of apples								
Cold		2	3		2	1	1	9
Common	1	1	1	3		4	2	12
Freshly harvested		1	4	2	3	2	2	14
Treatment before pasteurization								
None						1		1
Centrifuge			1	1	1	1	1	5
Direct filtration	1		4	2		1	2	10
Heat					1	2	1	4
Pectinol		4			3	2	1	10
Gelatin-tannin			2					2
Bentonite			1					1
Heat and bentonite				2	1			3
Added ascorbic acid		1	2	1	1		1	6
Deaeration							2	2
Acidity, as malic								
Less than 0.4%		2	3		1	3	3	12
0.4 - 0.61%	1	2	5	5	4	5	2	24
Degrees Brix								
Less than 13.0			4	5	2	5	5	21
13.0 and above	1	4	4		3	3		15

In the past 5 years, the production of apple juice has increased markedly. In 1940, 52 companies packed 4,400,000 gallons; in 1941, 40 companies packed 5,850,000; in 1946, 33 companies packed 10,776,380. The number of packers has become less, although the 1946 survey includes 5 new ones. There are 19 companies packing more than 100,000 gallons each.

The average flavor score in this survey is one point lower than in the previous two surveys. This might be due to the fact that the samples were about 2 months older and that they were shipped in warmer weather. The effect of temperature of storage is discussed below.

There is a trend away from deaeration, only two companies now employing it, and both of these juices were rated 2. The object of removing air is to prevent oxidation. It is doubtful, however, whether oxidation impairs the flavor of apple juice. Furthermore, considerable volatile constituent, "essence", is lost during deaeration, and this causes greater loss in flavor than is gained by prevention of oxidation.

Six companies now add ascorbic acid to their juice, partly for vitamin fortification and partly for flavor retention or enhancement. The meagre evidence in Table 2 shows that 3 companies, 24, 44, and 46, submitted samples without and with added ascorbic acid, and the flavor ratings were, respectively, 3 and 2; 7 and 7; and 8 and 6. Three other samples with ascorbic acid rated 6, 4, and 5. No packer added apple essence -- the product is probably still too new -- and no one used carbonation.

Pasteurization is now universal, no one using germ-proof filtration.

From Table 4 it is difficult to draw valid conclusions concerning the effects of the various items on the flavor ratings. Within the experience of these samples and the information submitted, flavor of the juice seems to be related to density and acidity. The juices having less than 13.0 Brix averaged 3.9 in flavor, while those above 13.0 Brix averaged 5.4. Further explanation of quality evidently rests in unidentified factors.

TABLE 5

COMPARISON OF 1940, 1941, AND 1946 SURVEYS

	1940 %	1941 %	1946 %
Typical apple flavor			
10-9, excellent	2		
8-7, good	28	15	14
6-5, fair	53	51	36
4-3, poor	17	32	36
2-1, objectionable		2	14
Container			
Glass	38	30	67
Metal	62	70	33
Storage of apples			
Cold	12	9	25
Common	75	15	33
Freshly harvested	13	55	40
Not stated		21	2
Method of processing before pasteurizing			
Pectinol	38	36	28
Gelatin-tannin	7	10	5
Heat	3	4	11
Centrifuge	3	8	14
Direct filtration	26	32	28
Bentonite		6	3
Heat and bentonite			8
No treatment	23	4	3
Deaerate	18	11	6
Appearance			
Cloudy	50	43	45
Clear	50	57	55
Total samples	54	47	36
Brix, average	13.5	13.5	12.9
Acidity, %, average	0.53	0.42	0.43
Production, 1000 gallon	4,400	5,850	10,776

Something can be learned by noting the trends from 1940 to 1946. In Table 5 various data are assembled in terms of the percentage of the number of companies. Since in 1940 and 1941 a scale of 1 to 5 was used, the values were multiplied by 2 to make them comparable to the 1946 scores.

A disturbing fact shown in the first section of Table 5 is that the proportion of juices of high flavor quality has become less. Particularly noteworthy is that in 1940, 2 percent were in the "excellent" class and none in the objectionable; while in 1946 none were excellent and 14 percent were objectionable.

There is a trend toward glass and away from metal for packaging, but this has been a matter of necessity and does not necessarily represent choice. The samples in glass averaged 1 grade higher in flavor than those in metal.

The use of apples from cold storage is increasing.

The proportion of clear and cloudy juices is unchanged.

Storage Temperature and Quality

Four pairs of samples, prepared in this laboratory in December, 1946, from equal proportions of high quality McIntosh, Jonathan, Stayman, and Northern Spy, were included with the commercial samples for evaluation. The lots had been divided and stored at 75° and at 35° F. The data on these samples are given in Table 6.

We call attention particularly to the fact that in every pair the 75° sample rated lower than the 35°. There was an average loss of two grades during the 7 months' storage. Considering now the commercial samples, let us assume that most of them were 6 to 8 months old when rated, and that they were not kept at a cold storage temperature during most of this period. Are their present flavor ratings, therefore, one or two grades lower than they were when first prepared? We are inclined to think that this is the case. If so, the flavor picture in Table 2 can be interpreted a little more favorably. When the juices were packed, there might have been a higher average score, there might have been some 9's and 10's, there might not have been so many 2's. The obvious indication is that juice should be stored at as cold a temperature as is feasible in order to maintain its original quality.

We have found that juice at 75° loses flavor within a few weeks. In some plants the packaged juice is about 100° when it leaves the labeling machines, is put in the cartons and piled in a mass of other cartons at the same temperature. It may be weeks before the pile attains a reasonable temperature, and during this initial period considerable flavor loss may occur.

In our questionnaire was the following: "How long does it take to cool the packaged juice to storage temperature?" We are afraid this was rather ambiguous, for the answers ranged from 1 minute to 48 hours. Obviously no useful interpretation can be made from the replies.

TABLE 6

DATA ON APPLE JUICE
PACKED AT EASTERN REGIONAL RESEARCH LABORATORY
AND KEPT FOR SEVEN MONTHS

Code No	Storage Temperature	Treatment Before Pasteurization*	Ascorbic Acid Added mg/100 cc	Ascorbic Acid Found mg/100 cc	Clarity	Sediment	Degrees Brix	pH	Acidity as Malic Acid %	Flavc
408	35	FHF	...	...	Hazy	+	11.8	3.3	0.46	6
	75	FHF	...	...	Hazy	+	11.8	3.3	C.46	5
409	35	FHC	...	...	Cloudy	+	12.2	3.4	C.48	6
	75	FHC	...	...	Cloudy	+	12.2	3.4	C.48	4
411	35	C	...	...	Cloudy	++	12.5	3.5	0.47	8
	75	C	...	...	Cloudy	++	12.5	3.5	0.47	4
412	35	C	40	37	Cloudy	++	12.4	3.5	C.47	5
	75	C	40	33	Cloudy	++	12.4	3.5	0.47	4

* FHF = flash heat and filter.
FHC = flash heat and centrifuge.
C = centrifuged.

Improvement in Juice

From the facts discussed above, it may be profitable to attempt some conclusions fc the improvement of apple juice. On the negative side, we can determine no relation between good or poor juice and the varieties used, the type of container, or the treatment previous to pasteurization.

On the positive side, a Brix above 13 is favorable. Rapid cooling to 70° F. or bel and storage at much lower temperature will help to preserve the initial flavor of t juice. We can think of but one other major factor, one which is not considered her and which obviously cannct be determined in a survey of this kind the condition the fruit when pressed. This factor can determine whether the processed juice sta its storage life on a high or a low quality level.

Survey of 1947 Pack

For the 1947 pack of apple juice a different procedure will be followed in this sur At the beginning of the season each packer will be invited to send us a case select on a day when he thinks a good juice, but still one that is representative, is bein made. We shall store part of the case at 35° and the other at 75° F. This procedu should give a more accurate picture of the freshly made juice, determine on a broad scale the effect of storage temperature, and still give us an idea of what this bes juice is by the following June.

Summary

Twenty-nine producers of apple juice submitted 36 samples from the 1946 pack. The juice was solicited in May and analyzed and judged for flavor in June, 1947. For

flavor ratings a taste panel of 29 persons was used, scoring on a basis of 10 for best down to 1 for most objectionable. Each packer supplied information on his process and production.

A total pack of 10,776,380 gallons was reported, compared to 5,850,000 in 1941 and 4,400,000 in 1940. Of the total 35 percent was made in New York and New England, 27 percent in the Appalachian area, 22 percent in the North Central region, and 16 percent on the Pacific coast.

There is a trend away from deaeration and towards the use of ascorbic acid and the centrifuge.

There is no apparent relation between the flavor score in June and the processing items, such as container, deaeration, use of ascorbic acid, filtration, clear or cloudy type, and size of plant. Juices having a Brix above 13° are usually better flavored than those having less.

The flavor rating of the 1946 juices was lower than that of the 1940 and 1941 surveys. This may have been due in some degree to the greater age of the samples when judged and to the lower density of the 1946 juices.

Laboratory lots of juice were made from high-quality apples by various processes and then stored at 75° and 35° F. After 7 months, those stored at 75° averaged two flavor grades lower than the others. It is suggested that storage temperature might be an important factor in the flavor of commercial juices.